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# Mineral Development in Ontario North of 50°

Technical Paper #3

Silver

Dr. H. Strauss  
and  
Dr. E. T. Willauer

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the ROYAL COMMISSION on the  
NORTHERN ENVIRONMENT

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LAURENTIAN UNIVERSITY

1981

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However, no opinions, positions or recommendations expressed herein should be attributed to the Commission; they are solely those of the authors.





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## INTRODUCTION

The purpose of this chapter is to bring out several important points:

The short-run - known and economical - world silver reserves are most likely to run out between the years 1995 at the earliest and 2004 at the latest date;

In order to bring long-run silver reserves into the realm of the economically feasible, world prices of silver must rise to accommodate demand;

These two results are to be modified by the downward shift in demand resulting from the desilverization of photography, which is to be expected with considerable certainty after 1990, if not before; in turn, the horizon of short-run resource depletion will be pushed further away towards the end of this century while prices will not rise as steeply as initially stated. However, their swings will be accentuated through both increased uncertainty and a stronger tendency towards inventory disposal of silver wealth holders.

Greater investment in silver mining must be forthcoming at the end of the 1980s to meet rising demand whereby the prospect of photographic desilverization will exercise a delatory effect.

Canada will continue to benefit greatly from exporting silver especially in light of expected higher prices of the metal.

These are the main conclusions drawn from the analysis which has been organized in the following way:

Section I investigates the metal, its properties, qualities, usefulness and, especially, the conditions and possibilities of substitutes for silver. The use of silver is explored in Section II, which studies the consumption pattern in the United States and the general trend of silver consumption in the world, the U.S.A. and Canada. World mine production of silver is presented in Section III, which also examines Canada's and Ontario's stake in this area of mining. In addition, it tries to point out the positions of the most important producers of the world; this section concludes with a brief presentation of Canada's success as a silver exporter. At some point, however, it was necessary to attempt a reconciliation of a critical difference in statistical quantities between world's mine production and its consumption of refined silver.



World reserves and alternative supplies are scrutinized in Section IV. After a discussion of short-run and long-run silver reserves and their distribution among countries, much attention is given to the conditions and investment activities in the most important silver-mining countries. However, this cursory discussion does not lay any claim to have covered the field completely. Furthermore, the problem of silver inventories of wealth holders is touched upon to indicate possible magnitudes, potential and prospects which these stocks may exert at one time on the international silver market; no claim to perfection is made here either. Section V presents mainly the projections of silver prices, supply and consumption, and some of the consequences ensuing therefrom; it is followed by a general summary and the main conclusions.

## SECTION I: THE METAL

Silver, like gold, is a soft, isometric metallic element of whitish colour and occurs in a variety of forms. It can be found in volcanic and sedimentary rocks in veins and strings, in the upper parts of silver-sulfide deposits, although it is frequently associated with gold, copper, nickel, zinc, lead, platinum, tin and other metals. Therefore, it has a variety of complementary-joint minerals when extracted.

Silver has properties similar to gold as it is highly malleable, is an excellent conductive agent as concerns heat and electricity and will withstand oxidization and corrosion.<sup>1</sup> In contrast to gold, which keeps its lustre forever, silver has a tendency to tarnish.<sup>2</sup>

Silver is also a precious metal. It is used in coinage, jewelry and in luxury-type houseware where it also enters through electroplating. Modern photography is unthinkable without silver compounds which are sensitive to light. Silver is also used in dentistry and, finally, it is an important catalyst.

Is silver really that important? This question can be answered through an interesting anecdote which may illustrate the point. It was during the Second World War. Nuclear scientists had embarked upon the Manhattan Project, centering on the



construction of the atomic bomb. Their headquarters was in Oakridge, Tennessee, a new city that had sprung from the ground almost overnight. In order to produce fissible uranium, the existing uranium U 238 had to be transformed into U 235. For this purpose, a powerful electron centrifuge - a cyclotron - was required which had to be built with the use of a metal of great electric conductivity and good heat resistance. Although copper would have served the need well, a shortage of this metal existed and the choice fell on silver. The quantity demanded was 14,700 tons. There was only one institution that had such a hoard: the United States Treasury. When approached for this purpose, the Treasury's laconic answer was that silver is measured in troy ounces only. In the end, the silver was delivered and the rest is history.<sup>3</sup>

Just like all other metals, silver too has a number of substitutes. Besides copper in electricity, aluminum and rhodium are used in mirrors and other reflecting surfaces and thus stand in for silver. In surgical instruments, pins and sutures, it is tantalum which may take the place of silver, while stainless steel is another material which finds wide application in house and tablewares in competition with silver.

In the history of mankind, silver has always held a prominent place of esteem. Silver, in the form of utensils, jewelry and ornaments, was known already very early. Especially,

it entered the trade routes from Mesopotamia in the fourth century before Christ. It was valued so highly that Imperial Rome made it its main monetary metal. Ever since, silver has functioned in a monetary capacity. It was used - and abused through clipping and debasing - to serve the monetary function. Be it as a pure silver standard or as a bimetallic standard in combination with gold, people displayed a great trust in this metal. Even if not the base of a currency such as in countries run on non-metallic fiat standards, people attach an extraordinary quality to silver which is only exceeded by gold and, perhaps, by platinum. These metals seem to have that singular quality: the capacity to store and keep value. Thus, silver, besides all its other uses, is also a very important monetary metal, though junior to gold.

As a monetary metallic unit, silver's place may be taken by copper, nickel and aluminum and by copper-nickel and copper-zinc alloys. Though all are junior to silver, they may be considered substitutes. This point can be carried one step further in the sense that, eventually, paper and deposit-demand money must be recognized as potential substitutes for silver no matter how imperfect these types of fiat currencies are in the eyes of the public. Silver and these types of currencies are mutual substitutes - they are non-interest bearing assets.

One other area of substitution should still be mentioned.



The demand for image retention is an important area with photography its most important medium. It is based on the light-sensitivities of silver halides. However, certain processes have been developed in photography which do without silver. For instance, the photocopier has become the most indispensable piece of office equipment of our time as it does something much cheaper than silver-based photography ever would. The best known of these processes is that developed by the Xerox Company. Yet, this is not the end of the process. Technological change is pushing the world further ahead with new and startling inventions. This is very noticeable in the field of image retention which can already now rely upon video-tape methods and video chips! It is fair to say that silver photography will one day be judged as " 20th century photography."

## SECTION II: CONSUMPTION

The purpose of this section is, at first, to establish the areas of silver use by order of importance, and secondly, to ascertain, as succinctly as possible within the limits of the given statistics, the use of the metal in the 'world,' the United States and Canada. In this attempt, two main categories have been identified: one is the silver needed by arts and industry and the other deals with the usage of this metal in coinage. In the second part of this section, consumption is viewed over the years from 1950 to 1979. The refined silver which is consumed comes from primary metal, melted coins, old, recycled scrap and sludge, and from existing silver stocks. These stocks may be in the hands of private individuals, financial institutions, governmental and monetary authorities, warehouses of commodity exchanges dealing in silver as well as in commercial and manufacturing firms of the silver trade.

### Consumption Pattern: U.S.A.

There is no doubt that photography is the greatest user of silver. On the base of the statistics presented in Table 1, photography consumed over 37 percent of that refined metal in the United States. It appears that the significance of silver



Table 1

	1974	1978	<sup>8</sup> Δ	1974	1978
1. Photography	49.6	60.0	20.97	28.02	(+) 37.62
2. Silverware	35.4	26.5	-25.14	20.00	(-) 16.62
3. Brazing alloys and Solder	14.5	11.0	-24.13	8.19	(-) 6.90
4. Catalysts	7.3	8.8 <sup>1</sup>	20.55	4.12	(+) 5.52
5. Jewelry	5.2	7.2 <sup>2</sup>	38.46	2.94	(+) 4.51
6. Electro Products	4.2	6.2	47.62	2.37	(+) 3.95
7. Coins and Medallions	22.3	2.9	-86.55	12.60 <sup>3</sup>	(-) 1.82
8. Dental and Medical Supply	2.4	2.0	-16.67	1.36	(-) 1.25
9. Mirrors	3.9	2.0	-48.72	2.20	(-) 1.25
10. Miscellaneous	<u>32.2</u>	<u>32.8</u>	<u>3.11</u>	<u>18.20</u>	<u>(+) 25.56</u>
	177.0	159.5	-9.89	<u>100.00</u>	<u>100.00</u>

<sup>1</sup>1976 = 12.3      Source: ABMS.      Non-ferrous Metal Data 1979, New York, N.Y.

<sup>2</sup>1975 = 12.7

<sup>3</sup>includes coinage

consumption in this field is still rising in both absolute and relative terms. It has been expanding faster than the other uses. This general trend may be observed either from Table 1, by comparing the performance of photography between the years 1974 and 1978, or from Table A1, which has been placed into the Appendix to this chapter. This Table A1, which is of a more recent vintage than Table 1, displays the silver consumption by type for the years 1978 and 1979. Unfortunately, the set-up is different from Table 1, preventing complete comparability between the two statistics. When tracking back further into the past, it can be illustrated that, for instance, in 1964, silverware was more important in the United States than photography: silverware absorbed 28.3 percent of the refined silver, while photography consumed only 27.8 percent. Since the absolute volume of silver-use in the United States has not changed substantially since 1964, the present 37 percent for photography compared to the 16.6 percent of silverware clearly testifies to its predominance over all other uses!

There are, of course, other purposes served by silver which are also on the incline. They are three: catalysts, jewelry and electro-products. Together they account for 14.0 percent of all refined silver consumed in the United States, displaying a combined addition of over 4 percent between the years 1974 and 1978.



On the reverse side, it is not a surprise that the usage of silver in certain areas has been on the decline. Coins and medallions display the greatest difference of the items between 1974 and 1978, with but a small absolute increase noticeable for the years 1978 and 1979 (Table A1). The statistics for the year 1964 do not lend themselves to this comparison because commemorative coins and medallions have been separated from official coinage, which, at that time, played a substantial role in the United States.<sup>4</sup> For the United States, the use of silver coins for any of these purposes has almost completely disappeared.

Another two items which do not meet favourable reception by industrial users are 'mirrors' and 'brazing alloys and solder'. With respect to silver used for mirrors, sufficient and reasonably priced substitutes are available, especially in the form of aluminum. The reduction in consumption of brazing alloys and solder may be explained by both a recessionary economy during those years and rising prices of silver.

The quantity of silver absorbed for dental and medical instruments and supplies seems also to be on the decline, at least according to Table 1. This could be the result of other substitutes which are readily available.<sup>5</sup> Nonetheless, these last items are too small to have a great impact on the general picture of silver consumption.

Consumption: Arts and Industry and in Coinage

The direct use of silver in the world may be classified into two categories: one refers to all industrial uses discussed so far with the exception of coinage; the other is coinage itself. In this way, world consumption of refined silver can be described although some qualifications are necessary. The point is that in the world total - let us say - for the year 1950, 201.5 million ounces were consumed of which 181.4 million troy ounces in both categories were accounted for by just seven countries. The remainder of 20.1 million ounces would have been at the disposal and consumed by all the remaining, not centrally controlled nations. For the year 1979, the picture would not be much different. Total consumption almost doubled. Nine countries are reported to have consumed 400.4 million troy ounces of refined silver - or 92.5 percent of all silver consumed, while 32.4 million ounces - or 7.5 percent - were the consumption of the other countries. On these grounds world total consumption of silver has to be taken as partial total consumption only!

Arts and Industry

World

In 1950, the 'world' consumed 157.4 million troy ounces of refined silver in arts and industry which steadily rose over



time until the peak year of 1973. In that year, industry and arts were reported to have absorbed 471.5 million ounces. It meant an increase of 170 percent over the three year average of 154.8 for the base period 1950-1952. In the years following 1973, this type of consumption levelled off, but it remained relatively stable. The lowest of this 'world' consumption was 387.1 million ounces which occurred in 1975, indicating a substantial drop of 20 percent from the height of 1973. From then on, the long-entrenched rising trend was to pick up again as is discernible in Table 2.

#### U.S.A.

The development of silver consumption by arts and industry in the United States was less spectacular. It rose from 120 million ounces in 1950 to peak in the same year as the 'world' by recording 195.9 million ounces as inputs into this sector. This meant a rise of only 80 percent or less than half the increase in the rest of the 'world'. Afterwards, it endured the same drop as the world as a whole as consumption went down to 157.7 million in the year 1975. This was equivalent to a reduction by 19.5 percent. Silver consumption in this area did not recover as quickly in the United States as experienced by the 'world'. By 1979, it had risen to 165.6 million ounces, an increase of merely 5 percent over the 1975 trough. This compares unfavourably with the 8.8 percent improvement of the

Table 2

Consumption of Silver by Arts and Industry and in Coinage for the  
World, U.S.A. and Canada in millions of ounces  
for the Years 1950 to 1979

Year	World		U.S.A.		Canada	
	Arts and Industry	Coinage	Arts and Industry	Coinage	Arts and Industry	Coinage
1950	157.4	44.1	120.0	24.6	5.2	3.4
1951	165.0	90.5	110.0	44.4	4.4	3.1
1952	142.1	114.3	95.0	57.3	3.8	3.0
1953	168.3	90.8	105.0	42.8	4.7	3.8
1954	160.8	83.5	85.0	53.2	3.9	.9
1955	192.8	52.6	100.0	8.2	4.6	2.6
1956	210.2	56.7	100.0	31.4	3.8	3.2
1957	213.0	84.3	95.0	52.1	5.8	3.8
1958	187.4	65.0	85.0	38.1	3.9	4.7
1959	211.8	84.9	100.0	41.4	4.4	5.7
1960	224.6	103.9	100.0	46.8	4.3	7.5
1961	239.5	137.1	105.0	55.9	6.5	6.2
1962	258.5	127.6	110.0	77.4	4.9	10.9
1963	260.7	166.4	110.0	111.5	4.6	13.0
1964	299.2	267.1	123.0	203.0	5.0	13.7
1965	336.6	381.1	137.0	320.3	5.3	20.4
1966	355.1	130.4	150.0	53.6	5.8	15.5
1967	348.6	89.1	145.0	43.8	5.4	8.8
1968	347.3	59.5	145.0	36.8	5.1	4.3
1969	362.4	43.7	147.0	19.4	5.4	0.1
1970	338.9	26.9	128.4	0.7	6.0	0.1
1971	351.4	27.2	129.1	2.5	6.0	0.2
1972	391.3	36.5	151.1	2.3	7.4	0.1
1973	471.5	21.0	195.9	0.9	9.6	1.5
1974	415.0	33.0	172.0	1.0	8.5	15.3
1975	376.8	38.0	157.7	2.7	10.6	10.4
1976	418.2	30.0	170.5	1.3	9.5	11.9
1977	387.1	23.0	153.6	.4	8.8	.3
1978	388.0	35.0	159.5	.1	9.0	.3
1979	410.0	22.8	165.6	.1	9.2	.3

Source: ABMS., Non-ferrous Metal Data, -1979, New York, N.Y. and  
ABMS., Yearbook, 1951(1950)- ,

total. Properly separated, the remainder of the 'world' - i.e. without the United States - displayed a rise from 219.1 million ounces to 244.4 million ounces, an upward change of 11.1 percent. It is, therefore, fair to say that silver consumption in arts and industry rose about twice as fast in countries outside the United States than in the United States itself.

The following picture emerges:

in millions of ounces						
Year	U.S.A.	change	%change	'World' without U.S.A.	change	%change
1950-1952	108.36			46.47		
1979	165.6	57.3	52.9	244.4	197.93	325.9

---

Precisely speaking, the United States silver consumption rose by 52.9 percent over the use period 1950-1952, whereas the remainder of the world expanded by 325.9 percent. Consumption growth outside the U.S.A. was about 6.2 times greater than in the United States.



Consumption of Silver in Arts and Industry of Different  
Countries for the Years 1950 and 1979  
in million of Troy ounces

Country	1979	1950	Percentage change
Canada	9.2	5.2	76.9
France	21.5	1.3	1,553.8
West Germany	37.1	7.6	388.2
India	19.0	-	n.a.
Italy	33.0	-	n.a.
Japan	65.5	3.0	2,083.3
Mexico	6.2	-	n.a.
U.K.	26.5	12.4	113.7
U.S.A.	165.6	120.0	38.0
Other countries	26.4	-	n.a.
'World'	410.0	157.4	160.5

Specifically, this breakdown of silver consumption in arts and industry by countries clearly shows where the important changes have occurred. It is in the countries of Europe and in Japan that silver usage has increased phenomenally during the period under investigation. Between 1950 and 1979, Japan's silver consumption rose by 2,083 percent or almost 22 times. France expanded the use of refined silver in this context by 1,554 percent or by a factor of 16.5, while West Germany saw its silver use go up by 388 percent or roughly 4.9 times over that timespan. Does this need any further explanation of what is going on among the industrial competitors on this earth?!

## Canada

Canada's performance in this area was better than that of the United States, at least in relative terms. Still, it was lagging behind the other industrial countries. From 5.2 million ounces absorbed in 1950 (or an average of 4.47 million ounces for the years 1950-1952) the use of this shiny metal rose to 9.6 million ounces by 1973. It did peak only two years later with 10.6 million ounces absorbed. Until 1973, this upward change was 114.8 percent over the base period 1950-1952, and 137.1 percent up to the year 1975. Afterwards, silver usage started to level off, which was similar to what happened in the United States. In an overall comparison, as presented in the above breakdown between 1950 and 1979, Canada's silver usage rose by almost 77 percent. This is twice as much as that of the United States.

## Coinage

The amount of silver released annually into coinage for the period 1950 to 1979 is likewise very informative. In 1950, the 'world' minted 44.1 million ounces into coins for which the United States is accounted for by 24.6 million ounces. The trend was slowly rising until the early 1960s. Canada followed the general trend, starting with 3.4 million ounces as coined in 1950 and doubling this volume around the year 1960. What

followed, then, came as a surprise. Ever and ever more silver went to the mints, and in 1965, 381.1 million ounces were devoted to coinage, of which 320.3 million were reported by the United States.<sup>5</sup> Canada took part in this coinage spree as the annual coin stamping output doubled.

Subsequently, minting activities changed drastically. Annual 'world' coinage declined steadily and sharply, spearheaded by the United States. From a high of 320.3 million ounces of coins produced in 1965, the annual volume vanished to 0.1 million ounces or to 0.031 percent of its top performance. Expressed in metric tonnage, the decline went from 9,962.7 metric tons to mere 3.1 metric tons.<sup>6</sup>

Canada displayed the same listless behaviour although its mint was somewhat more active than the U.S. counterparts. This has been set out in Table 2. However, between 1974 and 1976, a sudden upsurge in coinage occurred in Canada. This was the time when Canadian Olympic coin series were put into public circulation. When the games were over, the silver activities of the mint returned to their previous low level.

One obvious problem in the area of coinage was that coins served a monetary function. Unfortunately, the increase in coinage almost coincided with the devastating 'noise' of the greasing of the deposit pump. The flood gates of deposit money



were opened wider and wider every year, which undermined the credibility of the currency. What had happened to gold was experienced much more clearly by silver. Silver coins became very attractive and today, hardly any real silver coins can be found in the hands of the public. They have been driven out of circulation verifying Gresham's eternal law: the deposit money, the 'bad' money, has driven the silver coins, the 'good' money, out of circulation!!

#### Silver Consumption: Summary Account

As Table 3 illustrates, 'world' consumption of silver increased sharply from 1950 until 1965/66; afterwards it fell to 437.7 million ounces in 1967. In the following years, it fluctuated around this value ending with 432.8 million ounces in 1979. This steep rise in the early 1960s was the result of accelerated coinage activities, especially in the United States. By the year 1979, coinage made up only a very small portion of the total.

For this 'world', 78.1 percent of all refined silver went into arts and industry in 1950.. By 1965, this relative share had declined to 46.9 percent; but by 1979, it stood at 94.7 percent. Conversely, the importance of coinage rose from 21.9 percent to 53.1 percent in 1965, only to fall back to a mere 5.3 percent at the end of the period under investigation.

Table 3

World Silver Consumption and Distribution by Arts, Industrial and  
Coinage Use for the World, U.S.A. and Canada  
for the Years 1950-1979  
(millions of troy ounces)

Year	World consumption	Arts & Industrial Use %	Coinage Use %	Arts & Industrial U.S.A. %	Coinage Use U.S.A. %	Arts & Industrial Canada %	Coinage Use Canada %
1950	201.5	78.1	21.9	59.6	12.2	2.6	1.7
1951	255.5	64.6	35.4	43.1	17.3	1.7	1.2
1952	256.4	55.4	44.6	37.1	22.3	1.5	1.2
1953	259.1	64.9	35.1	40.5	16.5	1.8	1.5
1954	244.3	65.8	34.2	34.8	21.8	1.6	0.4
1955	245.4	78.6	21.4	40.7	3.3	1.9	1.1
1956	266.9	78.7	21.2	37.5	11.8	1.4	1.2
1957	297.3	71.6	28.4	32.0	17.5	2.0	1.3
1958	252.4	74.2	25.8	33.7	15.1	1.5	1.9
1959	296.7	71.4	28.6	33.7	14.0	1.5	1.9
1960	328.5	68.4	31.6	30.4	14.0	1.3	2.3
1961	376.6	63.6	36.4	27.9	14.8	1.2	1.6
1962	386.1	67.0	33.0	28.5	20.0	1.2	2.8
1963	427.1	61.0	39.0	25.8	26.1	1.1	3.0
1964	566.3	52.8	47.2	21.7	35.8	0.9	0.2
1965	717.7	46.9	53.1	19.1	44.6	0.7	2.8
1966	485.5	73.1	26.9	30.9	11.0	1.2	3.1
1967	437.7	79.6	20.4	33.1	10.0	1.5	2.0
1968	456.8	85.4	14.6	35.6	9.0	1.3	1.1
1969	406.1	89.2	10.8	36.2	4.8	1.3	0.0 <sup>1)</sup>
1970	365.8	92.6	7.4	35.1	0.0 <sup>2)</sup>	1.6	0.0 <sup>3)</sup>
1971	378.6	92.8	7.2	34.1	0.1	1.6	0.0
1972	427.8	91.5	8.5	35.3	0.5	1.7	0.0
1973	492.5	95.7	4.3	39.8	0.2	1.9	0.3
1974	448.0	92.6	7.4	38.4	0.2	1.9	3.4
1975	414.8	90.8	9.2	38.0	0.7	2.6	2.5
1976	448.2	93.3	6.7	38.0	0.3	2.1	2.7
1977	410.1	94.4	5.6	37.5	0.1	2.1	0.1
1978	423.0	91.7	8.3	37.7	0.0	2.1	0.1
1979	432.8	94.7	5.3	38.2	0.0	2.1	0.1

Source: ABMS., Non-ferrous Metal Data, -1979, and ABMS., Yearbook, 1951 (1950-1979), New York, N.Y.

1) Canada: no recorded use above 50,000 oz;

2) U.S.A.: 700,000 oz;

3) Canada: no recorded use above 50,000 oz;  
1971 = 200,000 oz, 1972 = 100,000 oz.

The United States consumed 71.8 percent of the 'world's' refined silver. By 1965, this share had declined to 48.5 percent. Temporarily, it jumped to 63.7 in 1965 due to the huge minting of coins. Finally, the U.S.A. silver use for the combined components dropped to 38.2 percent of the 'world' total. This performance has been brought forth in Table 3. The Canadian picture is almost identical in relative terms. In 1950, 4.3 of all refined silver of the 'world' was used up in Canada. Although we succeeded in doubling our total consumption in absolute terms, Canada had lost half its share by 1976, mainly due to an understandably weak coin output.



### SECTION III: MINE PRODUCTION OF SILVER

#### World Mine Production

A straightforward picture emerges. Between 1950 and 1979, world silver production doubled as it rose from 5,500 to 10,519 metric tons. This is brought out in Table 4. Annual changes were in both directions, but the overall pattern was one of a continuous upward movement with some acceleration built into the production - time relationship, a performance which has been plotted above.<sup>7</sup>

A substantial jump did occur in this string of values. It took place between the years 1967 and 1968. The main reason for this step was that the production figures up to 1967 excluded the estimated silver contribution from the U.S.S.R., whereas from 1968, the respective estimates by the U.S. Bureau of Mines have been included.<sup>8</sup> An additional reason for this sudden increase has to do with a specific event in silver output which took place in Canada.

#### Canada and Ontario

In 1950, Canada's mines produced 722.3 metric tons of silver. Annual output rose to an interim peak of 1,058 metric tons in 1960. Output remained stable for another seven years except that during this period, between 1961 and 1964, annual production had been allowed to subside slightly. The year

1967 signalled a major change. Silver production increased by 120 metric tons for that year. The period from 1968 until 1973 marked the time of the highest production levels. Extraction ranged from 1,354 metric tons in 1969 to 1,477 metric tons of output in 1973, the peak year. After that particular year, annual output did not continue the previously and firmly established upward trend. As a matter of fact, Canada appeared to have had difficulties in maintaining its annual output levels. The year 1977, which was the last one before major labour problems beset the mining industry, especially in Ontario, showed a silver output of 1,330 metric tons. This reflected the overall level at which it had settled. Therefore, the general performance presents a rising trend with one interim peak in 1960 and three major peaks in 1968, 1971 and 1973, with a marked relaxation to follow. Note also that the huge Canadian jump of 242.8 metric tons took place in 1968, the year the U.S.S.R. statistics became available.

On the world scene, Canada has always been a significant producer of silver, rising from 13 percent of the world total to 17.5 percent in 1967. After the Centennial celebration, it continued with a rising output, but at a reduced share. The year 1979 recorded Canada's contribution to the world output of mined silver to be equivalent to 11.25 percent.

Table 4

World and Canadian Mine Production of Silver (Metal Content of Ore) and Distribution for Canada and the Province of Ontario For the Years 1950-1979

Year	Output metric tons		Percentage Distribution		Consumption x 100 Production
	World (1)	Canada (2)	Canada (3)	Ontario (4)	
1950	5,500 <sup>1)</sup>	722.3	13.13	2.51	14.0
1951	5,400	719.3	13.32	2.60	47.1
1952	6,000	784.5	13.08	3.36	32.9
1953	6,100	884.1	14.49	2.64	32.1
1954	5,900	967.9	16.41	2.87	28.8
1955	6,100	870.4	14.27	3.09	25.1
1956	6,200	884.3	14.26	3.32	33.9
1957	6,500	896.5	13.79	3.31	42.2
1958	6,600	969.3	14.69	4.63	18.9
1959	6,200	992.9	16.01	5.29	48.8
1960	6,300	1,058.0	16.79	5.54	62.2
1961	6,300	976.1	15.49	4.38	85.1
1962	6,500	946.6	14.56	4.49	84.7
1963	6,600	928.1	14.06	4.51	101.3
1964	6,500	930.1	14.31	4.75	171.0
1965	6,800	1,004.0	14.76	4.95	228.2
1966	6,900	1,037.0	15.03	4.90	118.8
1967	6,600	1,157.2	17.53	6.91	51.5
1968	8,730	1,400.0	16.04	7.78	44.1
1969	9,250	1,354.0	14.64	7.49	36.5
1970	9,620	1,376.0	14.30	6.42	18.3
1971	9,340	1,432.0	15.33	6.22	26.1
1972	9,470	1,393.0	14.71	6.43	40.5
1973	9,670	1,477.0	15.27	6.31	58.4
1974	9,290	1,332.0	14.34	5.98	50.0
1975	9,330	1,235.0	13.24	4.97	38.5
1976	9,690	1,281.0	13.22	5.24	43.8
1977	10,240	1,330.0	12.99	5.18	24.6
1978	10,720	1,266.8	11.82	4.12	22.8
1979	10,519	1,183.9	11.25	4.16	28.0

Source: United Nations: Statistical Yearbook, New York, N.Y. Computation by the writer; ABMS. Non-ferrous Metal Data, 1979, New York, N.Y., p. 109.

1) See note 11: 1950 6246.



Ontario fared comparatively better. From being a small world producer which contributed 2.5 percent in 1950, its output rose over the years with some subsidence noticeable after 1960. By 1968, this Province managed to extract 7.8 percent of the silver mined in the world, thus becoming a very substantial supplier of the metal to the world. Unfortunately, this position was slowly eroded and in 1977, Ontario's world share had slipped to 5.18 percent. The values for 1978 and 1979 are even lower, but it is clear that the long strike in the Sudbury Basin affected the results significantly, introducing a negative bias into the Canadian and Ontario indicators.

#### Reconciliation between Refined Silver Consumption and Mine Production

If one compares the 'world' consumption of refined silver and the world production of mined silver, a very surprising situation can be observed: the consumption is much larger than the mining output. In 1950, such a tabulation shows an excess of 14 percent, which went to 228.2 percent in 1965. Later, it fell back to values similar to those existing before the big rise. These values have been set out in column (5) of Table 4.

These differences may be explained in the following way. In 1978, 423 million ounces of refined silver were consumed, a figure brought out in Table 5, which is the same value as in

Table 3. Of these 423 million ounces, 158 million were supplies coming from stocks and inventories; this is equivalent to 37.4 percent of the total, the greatest share being salvages - i.e. secondary sources of production.<sup>9</sup>

In the United States, the amount of refined silver in 1978 came from three sources:

47.98% primary production

1.01% coins

51.01% from old scrap

The total amount was 113.35 million ounces (or 3525.66 metric tons). A full 51 percent was recovered old scrap, photographic and other electrolytic sludges. On a world-wide basis, this recycled material counted for 19.9 percent of total consumption; 3.3 percent consisted of demonetized coins and India and Pakistan released substantial stocks into the silver market.<sup>10</sup> The authorities of the United States and those of other governments, too, provided silver from official stocks, while other, private institutions and individuals added another 4 million from holdings of silver.

The new, primary production was 265 million ounces or 8,242.61 metric tons, accounting for 62.6 percent of final consumption. This value, however, differs by 2,477.4 metric tons from the 10,720 metric tons stated in Table 4, leaving an obvious error of -23.1 percent. This difference can largely be

Table 5

World Silver Supplies and Distribution by Source for the Year  
1978 in million of troy ounces and percent

Source	<u>New Production</u>	
	Millions of troy ounces	Percent
Mexico	53.4	12.6
U.S.A.	38.0	9.0
Canada	39.9	9.4
Peru	31.0	7.3
Other American countries	19.0	4.5
Australia	27.5	6.5
Others	56.2	13.3
Total new production	265.0	62.6
<hr/>		
	<u>Other Supplies</u>	
U.S. Treasury	0.1	0.0
Foreign Government Stocks	8.4	2.0
Demonetized Coins	14.0	3.3
India and Pakistan	47.5	11.3
Salvage and misc. sources	84.0	19.9
Liquidation from private Stocks	4.0	0.9
Total other supplies	158.0	37.4
Supplies available for consumption	423.0	100.0

Source: American Metal Market, Metal Statistics 1979,  
Fairchild Publication, New York, N.Y., p. 168.



accounted for by two supply aggregates which have been excluded explicitly from Table 5.

Item I: U.S.S.R.: Output 1978 1,430.6 metric tons

Item II: Other centrally controlled<sup>11</sup> countries:

Bulgaria, East Germany, Hungary, Poland,<sup>12</sup> Rumania,

Czechoslovakia, China, North Korea

output 1978	928.9 metric tons
	<u>2,359.52</u>
+ 8,242.6	(Table 5)
	<u>10,602.12</u>
-10,720.0	
-	(117.88: 10,720.0) x 100 = -1.1%

This small computation shows that after the production of the centrally-controlled economies has been included, the margin of error has been reduced to -1.1 percent, which is, for all intents and purposes, insignificant and can arise from differences in the statistics from the various sources used. Eventually, it has to be remembered that there are many 'stations' on this road from 'mined to refined' product!

## World Producers

### Large producers

According to the statistics of the United Nations, there are about 50 silver-producing countries in the world. They may be divided into three groups: large, medium and small. Of these, the first two are of interest since they are the main competitors in the world market and account for 90 percent of

the mined silver in the world.

Seven countries make up the list of large producers, each extracting very much in excess of 5 percent of the annual total; the 5 percent constituting the dividing line between large and medium-sized producers.

In the year 1950, Mexico was the world's largest silver-mining country, supplying 27.8 percent of silver in ores to the world. It still is the largest supplier, though its output share has shrunk to 14.58 percent for the year 1979.

The second largest silver producer in 1950 was the United States, then holding a market position of 23.93 percent. Today - 1979 that is - it is tied with Peru in fourth place, accounting for just below 11 percent each of world silver mine production. The place of the second largest producer has been occupied by the Soviet Union!

The Soviet Union was not included in the statistics of the United Nations for the years prior to 1968. Estimates from other sources assigned to the U.S.S.R. a silver production of 746.5 metric tons for the year 1950.<sup>11</sup> On this basis, the U.S.S.R. would have been the third largest producer then, and not Canada as indicated in Table 6.

As the Soviet Union moved from third to second place during this entire period under study, so Canada changed its

Table 6

Distribution of Silver Production by Main Producing Countries  
for Selected Years in percentage value

Metric tons volume of output	1950	1955	1960	1965	1970	1975	1979
	5,500	6,100	6,300	6,800	9,620	9,330	10,519
Country							
Australia	6.04	7.42	7.51	7.90	8.90	7.82	7.33
Bolivia	3.71	3.02	2.41	1.88	1.54	1.82	1.70
Canada	13.13	14.27	16.79	14.76	14.30	13.24	11.25
Chile	0.00	0.87	0.70	1.50	0.79	2.08	2.45
France	0.41	0.93	0.51	0.64	1.56	1.15	0.71
Japan	2.45	3.73	3.41	4.12	3.57	2.92	2.56
Mexico	27.79	24.46	21.98	18.45	13.85	12.68	14.58
Peru	7.55	11.70	16.12	16.68	12.65	11.91	10.94
Poland	not recorded before 1968				1.25	4.39	6.80
South Africa	0.65	0.75	1.10	1.43	1.14	1.03	0.93
Namibia	0.36	0.65	0.52	0.70	0.40	0.48	0.46
Spain	0.32	0.79	0.88	0.90	0.53	0.11	0.89
Sweden	0.72	1.22	1.37	2.27	1.28	1.50	1.69
U.S.S.R.	not recorded before 1968				12.27	14.30	13.90
U.S.A.	23.93	18.60	15.19	18.21	14.55	11.65	10.96
Yugoslavia	0.76	1.52	1.49	1.90	1.10	1.80	1.54
Zaire	2.53	2.08	0.45	0.39	0.48	0.76	1.27
	90.35	92.01	90.43	91.73	90.16	89.64	89.96

Source: United Nations, Statistical Yearbook, New York, N.Y.  
ABMS. Non-ferrous Metal Data, 1979, New York, N.Y.



rank from fourth to third. In 1950, Canada controlled 13.1 percent of silver mining, which, by 1979, recorded only 11.25 percent, a slight diminution of its position of the year 1975. This reduction was the result of cutbacks and of labour problems in the industry in the years 1978 and 1979.

As indicated, fourth place is shared equally between the United States and Peru; the latter had moved upward in rank from fifth place in 1950. Interestingly enough, Peru displayed an exceptional performance in the middle of the 1960s when it rose to become the world's third largest producer of silver in the world with the production share at 16.7 percent.

The fifth largest producer in 1979 was Australia (7.3%) which was one step higher than the position held in 1950 (6.0%).

The surprising runner-up to sixth place in 1979 is a country which had not been noticed on the silver scene for a long time.<sup>12</sup> From an insignificant silver-mining country, Poland featured 6.8 percent of the world total.

In short, these seven countries produced three quarters of the silver mined in the year 1979.

#### Medium-sized producers

The medium-sized producers supplied 14.2 percent of the 1979 silver output. They may be arranged briefly by ranks of importance:

rank	1979 share	Country	1950 share
7	2.56	Japan	2.45
8	2.45	Chile	----
9	1.70	Bolivia	3.71
10	1.69	Sweden	0.72
11	1.54	Yugoslavia	0.76
12	1.27	Zaire	2.53
13	0.93	South Africa	0.65
14	0.89	Spain	0.32
15	0.71	France	0.41
16	0.46	Namibia (small)	0.36

Japan is at the top of the list followed by two South American countries: Chile and Bolivia. Next is Sweden which also has been successful in expanding its silver output at a faster rate than the world average. This is likewise true for Yugoslavia, number eleven among the world silver producers. In contrast, Zaire has lost considerable ground, while the last three countries, South Africa, Spain and France have gained on the world during this long period of time, though on a relatively small scale of operations. Namibia, which actually belongs to the group of small producers, has been added since it is still under the authorities of South Africa to which the output volume could be added.

#### Small producers

The remaining countries, about thirty-two in number, comprise the small silver-mining camps. They are responsible for the final 10 percent of total production. In essence,

they are unimportant because as competitors, they are unlikely to influence the situation in the silver market, nor will they repeat the performance of Poland to emerge in the group of major suppliers!

#### Canada's Foreign Trade in Silver

Canada's foreign trade in silver covers primarily two types of silver substances: ores and concentrates, and metallic silver. As to the former, only exports enter the picture. The magnitude of this silver export is presented in Table 7, pointing out the salient features for the years 1977 until 1979.

In the year 1977, Canada exported 15.3 million ounces of silver contained in ores and concentrates for a return of \$61.3 million. One year later, 15.4 million ounces were shipped to bring home \$62.06 million. However, in 1979, the quantity declined to 13.3 million ounces, but, due to the general rise in silver prices, the return rose to \$94.9 million, a sizable contribution to our export balance.

For all three years, our main customers were the United States, Japan and West Germany. However, as also indicated in Table 7, Canada has increasingly shipped silver ores to the U.S.S.R. which seems to be on the road to becoming one of our main customers!!



Table 7

Canadian Exports of Silver Ores and Concentrates

Commodity Item 256-50

for the Years 1977 to 1979

Silver in Ores and Concentrates <sup>8</sup>				
	Exports(oz)	mt	Exports Value \$'000	Unit value of Shipment \$/oz.
1979	13,329,029	414.6	94,907	7.12
1978	15,424,470	479.7	62,061	4.02
1977	15,329,641	476.8	61,310	4.00

1979 U.S.A. 50.4%  
 Japan 28.9%  
 West Germany 10.0%  
 U.S.S.R. 2.4%  
 (Total number of customer countries: 13)

1978 U.S.A. 58.7%  
 Japan 25.5%  
 West Germany 7.4%  
 U.S.S.R. 0.8%  
 (Total number of customer countries: 13)

1977 U.S.A. 66.8%  
 Japan 21.6%  
 West Germany 4.4%  
 Belgium-Lux. 3.7%  
 U.K. 2.7%  
 U.S.S.R. 0.2%  
 (Total number of customer countries: 10)

As concerns metallic silver, Canada is both exporter and importer with the United States indisputably the most important trading partner. This is a very lucrative trade as Canada is a net exporter adding \$344 million to the trade balance in 1979 (Table 8), doubling the return over 1977, even at a reduced volume of shipments.

The overall balance is:

Year	<u>in metric tons</u>	<u>\$ Balance</u>	<u>metric tons</u>
	Net exports of silver in ores, concentrates and as metal		<u>Annual Mine Production</u>
1979	1285.0	438,883,000	1183.9
1978	1514.5	267,671,000	1266.8
1977	1585.7	233,583,000	1330.0

The overall balance ends with a total credit of 438,883,000 in Canadian dollars.

Finally, it can now be shown that Canada shipped more in silver than its mines produced. This excess of shipment over mine production was 101.1 metric tons in 1979, 247.7 in 1978 and 255.7 in 1977. It means that stocks and inventories of silver have been disposed of but that this disposal slowed down as time progressed. The result of all these activities is that silver behaves very much in the interest of this country and its balance of payments which cannot be said of the other precious metal: gold. The performance of silver mining is a great credit to the industry.

Table 8

Canadian Exports and Imports of Silver Metal (Commodity Item 455-50)  
for the Years 1977 to 1979

Year	Exports	Troy ounces		Balance	Value of shipments		
		Imports			Exports	\$'000 Imports	Balance
1979	29,159,844 <sup>2</sup>	1,175,674 <sup>3</sup>		27,984,170	348,947	4,971	343,976
1978	34,410,435 <sup>4</sup>	1,143,789 <sup>5</sup>		33,266,646	211,117	5,507	205,610
1977	36,711,569 <sup>6</sup>	1,061,091 <sup>7</sup>		35,650,478	177,136	4,863	172,273

Exports to		
1979	U.S.A.	96.3%
1978	U.S.A.	95.8%
1977	U.S.A.	95.8%
	U.K.	3.8%

Imports from		
1979	U.S.A.	89.3%
1978	U.S.A.	83.4%
	U.K.	15.5%
1977	U.S.A.	96.2%



#### SECTION IV: WORLD RESERVES AND ALTERNATE SUPPLIES

##### Reserves: Short and Long Run

Given the probable distribution of 0.2 ppm for silver, it has been estimated that the first outer kilometer of the earth's continental crust contains 79,000,000,000 tons of the precious metal.<sup>13</sup> Naturally, the interest here is centered on the known and probable mineral deposits which are, and/or could become, exploitable orebodies. Two alternative measures have been selected to serve as reserve indicators: one is a short-run measure, while the other considers economic as well as probable reserves over the long run.<sup>14</sup>

The long-run estimates set the world silver reserves at 704,000 (1974) metric tons,<sup>15</sup> while the known reserves in the short-run are 250,000 metric tons. Their distribution by country are contained in Table 9.

The two largest silver holders in the world are the United States and the Soviet Union. These figures are highlighted by their difference between the two estimates. In the short-run, Duncan R. Derry assigns much smaller shares to the United States and Russia than Clark's stated estimates do in the long run.

Table 9  
World Silver Reserves and Distribution by Country

Country	250,000 Metric Tons (Duncan R. Derry)	704,000 (U.S.B.M.'s Clarke) <sup>17</sup>
	%	%
United States	18.80	25.18
Canada	8.88	10.60
Mexico	10.56	15.47
Honduras	0.32	0.53
	Other American countries (north)	
Peru	7.60	7.95
Bolivia	0.80	2.70
	Other South American countries	
U.S.S.R.	16.00	30.93
Poland	8.00	2.22
Sweden	1.56	
Yugoslavia	0.65	
	Other European countries	
South Africa	3.04	0.88
	Africa	
Japan	0.60	0.40
Other Asian countries		0.49
Australia	10.00	2.43
Others <sup>16</sup>	13.19	0.22
	100.00	100.00

In addition, the order of magnitude is reversed between the two. In the short run, the reserves of the United States are greater than those of the U.S.S.R., while the long-run projection allocates much larger reserves to the U.S.S.R. than to the U.S.A.

A number of arguments could be raised in explanation of these differences. One proffered by geologists is that all reserve estimates, especially those over the long run, are highly questionable, if not suspect. But even if this might be the case, the assumption might be made that these are valid and relevant figures. Under these limiting circumstances, the obvious reversal in the order of significance would mean that the ore quality is poorer in the U.S.S.R. than in the United States.

The third largest holder of silver ores is Mexico, counting 10.56 percent in the short run and 15.47 in the long run. It means that North America on the whole, including Canada as number four with 8.8% and 10.6% respectively, accounts for over 38 percent and 51 percent of silver holdings in short- and long-runs respectively.

Peru is certainly the next largest holder of silver reserves with no noticeable difference between short and long-run estimates. Both estimates assign more than 7.5 percent of the world's total reserves to this South American country. However,

things are not that clear as far as Australia and Poland are concerned. For both, the long-run estimates of the year 1974 are very much smaller than Duncan R. Derry's of a later vintage. He assigns 25,000 and 20,000 metric tons to Australia and Poland respectively, whereas Clarke's potential - for the long run - are only 17,107 and 15,628 metric tons for the two respective countries. Obviously, a huge discrepancy exists between the two estimates which is difficult to explain, although the time difference as to when these estimates were collected plays an important role. Both countries discovered huge polymetallic orebodies! Without attempting to ferret out the various sources and references, which could explain the variations, there is a particular parameter suitable for determining the relative validity and relevancy of the two estimates: shares in world output, as established in Table 6.

Since there is a definite relationship between the quantity produced and the reserves of a country, it may be reasonable to suggest that the world shares held in recent years by both countries may be indicative of the "true" reserves. The recorded productive shares amounted to 7.33 and 6.80 in 1979 for Australia and Poland respectively. An upward adjustment in reserves for both countries is therefore justified such that the long-run reserves must be larger than given in Clarke's Table. Otherwise, both countries would be running out of



reserve very quickly, were their annual output shares greater than their proportion of world reserves.

The overall picture does not change and the fact remains that the largest resource holders of silver are: the U.S.A., U.S.S.R., Mexico, Canada, Australia, Peru and Poland. Their share is between 80 and about 90 percent of world silver sources, whereby the American countries have approximately 38 to 51 percent, depending on which estimate appears the more realistic of the two. The reserves of Sweden, Yugoslavia and of Bolivia are smaller such that the countries shall play a minor role on the silver scene in the future just as they have played in recent years.

#### Alternative Supplies

Two aspects of alternative supplies should briefly be investigated: one relates to investment and mining activities in the main silver-producing countries; the other relates to potential supplies which could be expected from existing and known silver hoards.

#### Alternative Suppliers

United States	Production 1950: 1,316 metric tons;
---------------	-------------------------------------

	1979: 1,152.8 metric tons
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The United States' silver is produced by about 225 mines. Idaho, with the Coeur d'Alene mining district, is a producer of

the native silver in the United States. It produces 48 percent, followed by Arizona with 19 percent, and Colorado with 8 percent. Utah, Montana and Missouri together account for 20 percent, while the other States deliver the remaining 5 percent.

Two thirds of this primary silver supply comes as a by-product from copper, lead and zinc mines. In addition, it is interesting to note that there are about seven mining firms in the United States which produce 63 percent of total silver mining output.

In spite of the fact that the United States is one of the two largest holders of silver ores, it is still necessary to import silver. For instance, in the year 1979, the United States imported 2,332 metric tons of silver, which is twice its mines' production. The main suppliers were Canada (37%), followed by Mexico (24%), Peru (15%), the United Kingdom (6%) and 18% coming from other countries.

The United States recognizes that its future demand and consumption of silver will have to be met to an increasing extent by imports, by withdrawal from existing stocks and through the use of secondary metal, including old scrap. There are two reasons for this increased reliance on non-mining production: the first is that the base metal industry, comprising

the mining of nickel, lead, zinc and copper, has experienced reductions in its activities due to a general decline in demand. Thus, silver which is a by-product of these operations has not been forthcoming from these sources; the second reason is that restrictions on output to limit emissions of pollutants as stipulated by the regulations of the Environmental Protection Agency have borne down significantly on all mining operations. Therefore, it should not come as a surprise that the United States has to look for silver to other sources.

Nonetheless, certain investment activities in the silver field are observed:

The Sunshine Mining Company which is one of the twenty major silver producers of the United States is building a new refinery at Big Creek in Idaho. This refinery should be in operation in 1981. For the following year, the same company intends to open up a new mine at Silver Peak, Idaho, to produce 1 million ounces of silver per year (31.1 metric tons). This output will come from an ore reserve of over 900,000 metric tons containing 9.24 ounces of silver and 0.033 ounces of gold. This grade is equivalent to a total silver content of 260 metric tons, sufficient to last well into the early 1990s.

Asarco has decided to exploit a silver-copper deposit in Troy, Montana at a cost of \$82.6 million. It is expected

to start in the middle of 1981 to produce 4.2 million ounces (or 130 metric tons) of silver and 18,100 metric tons of copper annually.

The Calahan Mining Company is planning to sink a shaft at the Calady property in the Coeur d'Alene silver mining belt in Idaho at a cost of \$26 million. This shaft, which will go down to 5,100 feet, will make possible the recovery of silver ore. It should be ready by 1985.

Capital Silver Mines plans a silver operation in Oshburn, Idaho, while Occidental Minerals is involved in Western Nevada in a silver and gold mining project which should produce 18 million tons of ore per annum. Federal Resources is reopening the Syracuse and Bachelor silver mines in Ouray, Colorado. Annual ore tonnage hauled should be over 110,000 metric tons. Hecla Mining plans to invest \$26 million to increase its ore capacity by 33.3 percent at Mullan, Idaho. This is an underground mine. The same company, in partnership with Coeur d'Alene Mines Corporation, Silver Dollar Mining and Sunshine Mining, will invest \$11 million in exploitation of leased properties of the Consolidated Silver Corporation, near Oshburn, Idaho. The present reserve is 60,780 metric tons, containing 22 ounces of silver per metric ton. The total program will take five years for completion.



Ranchers Exploration is investing \$25 million in the Escalante Mine in Utah. The expected silver output is 1.5 million ounces per year (or 46.7 metric tons).

Although these activities provide only a partial picture of the silver scene in the United States, there is no doubt that they are considerable and shall not fail to raise the output of the much needed silver in that country. These operations have also been made possible due to the much improved climate in the silver market where prices have substantially shifted upwards compared to a decade and more ago.

U.S.S.R.      Production 1950:    est. 746 metric tons

1979: est. 1,461.7 metric tons

Non-ferrous minerals are the chief source of silver output in the U.S.S.R. These silver-mining operations take place in the Far-East, Kazakhstan, East Siberia, the Urals and Armenia. About fourteen gold treatment plants also extract silver. In addition, the Norilsk complex and some enterprises of the famous Kola nickel-copper operation also produce silver.

In the Urals, it appears that the recovery from beneficiation plants ranges from 15 up to 50 percent from the complex ore material containing 6 to 15 grams of silver per metric ton of ore. Among lead concentrates, the silver content is about 68 to 86 grams per metric ton. It is, therefore, clear

that any increase in output of base metals, in which the U.S.S.R. is feverishly interested, must lead to further increases in silver output. Consequently, the rise of silver production in the Soviet Union from 746 metric tons in 1950 to 1,090 metric tons in 1968 and, eventually to 1,461.7 metric tons in 1979 can be explained, to a very large degree, through the rising output of base metals. In comparison to world silver production, the U.S.S.R. has accounted for 11.9 percent, 12.4 percent and 13.8 percent of world output for these respective years. Its silver output rose faster than that of the world as a whole. Likewise, there is no reason why this tendency should not continue!

Therefore, it stands to reason that the U.S.S.R. will become an even more important silver supplier in the course of its rapid industrialization.

Mexico	Production 1950:	1,528.5 metric tons
	1979:	1,533.5 metric tons

Mexico has a large number of silver producers and fourteen of these supplied about 83 percent of the metal delivered in the year 1979. The largest of all is Industrial Minera Mexico, accounting for 35.4 percent of the total. Certain investment activities are taking place and one can argue that, by 1983,

Mexico will have provided for between 450 and 500 metric tons of additional silver output resulting from these activities.

There is the Real de Angeles Company, a joint venture of Minero Frisco, Fomento Minero and Placer Development. This company has planned an open pit mine for the year 1983 and should produce about 217 metric tons per annum.

Avino Mines, a smaller company and not among the top fourteen silver producers, will add about 70 metric tons by an expansion of its capacity from about 110,000 metric tons to about 440,000 metric tons of ore per year. The Fresnillo Company will start an open pit mine in 1983. The mine should produce 650,000 metric tons of ore annually. Assuming a grade of 200 grams per ton, the expected output would amount to 125 metric tons per year.

There is another small mine but a very lucrative one: Lampazos silver mine. With a known and a possible reserve of 1,000,000 and 3,000,000 metric tons respectively, it is a very high grade mine.<sup>19</sup> Reserves would approximately range between 380 and 1,140 metric tons of the metal. Not far away from this mine is another deposit with a grade of 14.5 ounces of silver per ton.

It is, therefore, very likely that Mexico would add the above-mentioned amount of 450-500 metric tons of silver per year.

This is particularly true because Mexico has developed a definite industrial policy. However, this does not mean that the benefit from gold and silver mining goes to the mines. The recent increases in the prices of gold and silver have demonstrated the determination of the Mexican government to redistribute these profits. As American Metal Market reported early in 1980, the Mexican treasury announced that mining companies would pay a tax of 40% on gold and silver sales after subtracting the corresponding production taxes of an average of about 7 percent. Specifically, the tax would be applicable to any price in excess of a base price of \$10 per ounce for silver and \$264 per ounce of gold to be adjusted monthly according to increases in the Mexican City wholesale price index. These base prices referred to July 1979 prices.<sup>20</sup>

Australia	Production 1950: 332.1 metric tons
	1979: 771.3 metric tons <sup>21</sup>

Australia's silver is mainly a by-product of other (lead-zinc) base metal mines. There are five large mines which supply about 85 percent of the metal. The Mount Isa Mine is the largest of them all, accounting for 58.9 percent of the silver output in the year 1979.

Several lead-zinc investment projects will assure a continuous silver flow in Australia for years to come. The Elura lead-zinc deposits, near Cobar in New South Wales, owned by the



Electrolytic Zinc Company (EZ), contains an estimated silver reserve of about 3,750 metric tons. One hundred and eighty million dollars are to be invested in an open pit mine which will deliver approximately 150 metric tons of silver annually over an expected lifespan of 25 years. This mine will be in operation in December, 1982.

The Aberfoyle Group, which is owned to 45 percent by Cominco Australia, a wholly-owned subsidiary of Cominco Canada, is proceeding with the development of the Que River deposit. The known ore reserve of this copper-lead-zinc-silver orebody is 3 million metric tons with a silver content of about 500 metric tons. The overall size of this mineral deposit is about twice that much, making for a life-expectancy of this mine of over 30 years.<sup>22</sup>

Consequently, the silver production will be assured as long as reserves are available and as long as there is a strong demand for lead and zinc.

Peru      Production 1950:    415.8 metric tons

1979: 1,150.7 metric tons

Peru is as large a producer of silver as the United States, accounting for almost 11 percent of world output each in the year 1979. The largest silver-producing company in Peru is Empresa Minera del Centro del Peru (CENTROMIN) which alone

produced 792.8 metric tons in 1979 or 68.9 percent of Peru's silver. The second largest is Cia. de Minas Buenaventura. In total, there are at least one dozen major producers of silver ores and concentrates, with Centromin the largest refiner.<sup>23</sup>

It is understood that Cia. de Minas Buenaventura will raise its production capacity from about 28 to 59 metric tons of silver through an improvement of the underground concentrator and power facilities.<sup>24</sup> This expansion would imply an increase of but 2.5 percent in Peru's output.

Since there are other projects on the drawing boards of mining companies of that country - plans which are difficult to be ascertained - it is impossible to foretell the exact course of development of silver mining in Peru. However, substantial increases can be expected. For instance, Asarco's Quiruvilca has discovered a new orebody, and subsequently hopes to increase its output by 10 metric tons of silver besides the copper, lead and zinc contained in the ore.<sup>25</sup>

Although all these additions are of a small magnitude, they do reflect the great potential of Peru as a continuous future silver supplier to world markets.<sup>26</sup>

Sweden	Production 1950:	39.7 metric tons
	1979:	177.3 metric tons

Silver production in Sweden increased by 4.5 times over the study period. This is mainly due to the operations of

Boliden Metal AB, Sweden's largest producer of this metal. Apparently, Garpenberg Norra is the chief silver mine of the Boliden Group,<sup>27</sup> while other lead-zinc mines such as Laisvall are only marginally significant suppliers of silver as a by-product.<sup>28</sup>

In recent years, the Swedish mining industry has been facing difficult times due to rising energy costs and competition in the iron ore markets. However, substantial drilling and exploration work is taking place at numerous mines in an obvious attempt to consolidate Sweden's position in the non-ferrous metal field. Unfortunately, detailed results are not easily accessible,<sup>29</sup> although a slowly rising output of silver is still to be expected.

Yugoslavia	Production 1950:	74.2 metric tons
	1979:	162.0 metric tons

Between 1950 and 1979, Yugoslavia doubled its output of silver which is mainly a by-product of lead and zinc mining. Since Yugoslavia has substantial lead and zinc deposits and since considerable investments are taking place in these fields, a steadily rising output of silver can be expected. The output is therefore very likely to climb to an annual figure of 200 metric tons. This is not the result of a proper estimate, but follows by simply extrapolation.

Bolivia      Production 1950:    204 metric tons

1979: 178.6 metric tons

Silver production in Bolivia has declined over the period under investigation. This is, indeed, surprising considering that once this country was the world's largest source of silver. It has mined silver for over 500 years. Today, there are no native silver mines in operation in Bolivia. The steady flow of Bolivian silver comes as a by-product from lead, zinc and tin mining. As a matter of fact, the silver mining industry is now the smallest of all mineral industries in Bolivia.

The Bolivian mining firm, Corporacion Minera de Bolivia (COMIBOL), which is the largest in the country, has built new facilities to increase its output. So has the private firm, S.J. Groves, which had been expected to produce 15.5 metric tons of silver in 1980. Empresa Minera Unificada S.A. (EMUSA) planned to open another silver mine in Toldos, Sud Lipez, while the state-owned Empresa Nacional de Fundiciones (ENAF) and COMIBOL had plans for a lead-silver smelter. Nonetheless, there is no indication that the silver output of Bolivia will significantly exceed the generally observable output range of between 150 and 250 metric tons per annum.<sup>30</sup>

## Supplies from Stocks

The other side of silver supplies which may find their way into the markets is concerned with old, existing silver, a



form which stands in contrast to newly mined supplies. Naturally, little is known about the magnitude and distribution of these inventories. Yet, there is no doubt that private individuals, institutions and certain government hoards hold on to undeterminable quantities. One thing seems to be certain: they are large, although not always feasible to be melted into marketable bullion. One would think here of antique silver ornaments and utensils, especially museum pieces which have immeasurable cultural values.

Nonetheless, these silver hoards are overhanging the silver market and the holders of this type of wealth will divest themselves of silver in exchange for money, or gold and other valuables if they think the price is high enough to warrant such action; they will also, in turn, add to their holdings if they think the going price is low enough. On balance, wealth holders will bring silver prices down or up, depending on the market conditions. In this operation, the speculator - the person in demand of wealth - will take part and smooth the adjustment process, while the mineral producer must avail himself, as best he can, of the process which sets daily and future prices.

In this context, some indication of the sources of such supplies is given through information on some countries and on the odd individual situation. They shall be mentioned here briefly. The countries to be elaborated on are India - and

what holds for India may likewise be true for Pakistan - and China; an example of wealthy individuals is the episode surrounding the famous Hunt Brothers. And, of course, the U.S. government holds silver too.

India      Production 1950: 0.5 metric tons

1979: 14 metric tons

India is an exporter of silver to the world, especially to the United Kingdom, France, Switzerland and Germany. With the improvement of assaying procedures, India may even meet international silver specifications and tap the great U.S. market.

India has no native silver mines and the output is small coming as a by-product from the Karnataka gold operations. Nonetheless, silver exports amount to about 1,000 metric tons(!) which stems from a private silver stock of over 77,700 metric tons (!). Therefore, export demands may be met over decades to come regardless of the small silver mining output of the country. If prices rise, substantial additions to the world silver supplies can be expected to enter the market with negative effects of prices. This means also that India has a stock of silver for which the mines of the whole world would have to work over 7 years to match that quantity. In other words, India could supply silver at 1,000 metric tons per annum for another 77 years!<sup>31</sup>

## China

China has not been an important producer of silver and in this sense, it is similarly situated as India. No doubt, China has a potential to produce the shiny metal and it will increase its output, especially when its lead, zinc, tin and copper mines move into higher 'gear'.

Yet, there is the other aspect which again displays a great similarity to India. China, over its long history, has accumulated huge quantities of silver, be it from local ores, placers or from imports.

At one time, China was on the silver standard and it had to import silver from Mexico. This source of supply made up a substantial part of China's silver exports in the 1950s. In essence, it is the remaining hoard which may one day play a role in the silver market. Unfortunately, it is difficult to say anything specific about the circumstances surrounding this Chinese silver hoard.<sup>32</sup>

## The Hunt Hoard

There are many private individuals who have found great interest and fascination in holding and dealing in silver. No two people are more qualified to meet this description than Herbert and Bunker Hunt of Dallas, Texas, U.S.A. They came into the spotlight when the price of silver roared to unprecedented

heights, almost hitting the \$50/ounce mark. They were reported to be involved in a silver scheme and at one time they were reported planning to issue silver-backed bonds. Other reports tell us that they established international connections with similarly rich individuals, involving names like that of the late Shah of Iran - whom they could not convince - and other wealthy people in the Arab world. The Hunt Brothers, as they are generally called, were of the firm belief that the price of silver was much too low and that it should rise as paper currencies had lost credibility. Such purchase schemes would inevitably increase the price of the metal!

They invested considerable sums in this venture - \$4 billion at the height of the frenzy - until, due to a change in the rules at the COMEX, the price collapsed. When the smoke and dust over this fiery scene had cleared, Herbert and Bunker Hunt held a silver stock of 63 million ounces or 1,959.5 metric tons.<sup>33</sup> This is 1.7 times the annual output of all the silver mines of the United States. Also, they were left with a debt (line-of-credit) of \$1.1 billion. When related to the silver inventory, it means that a gross price tag of \$17.46 could be attached to each ounce. Comparing the prices of what they were then and what they are today, the Hunt Brothers are locked in, provided they have any intention of selling. As one of the members of the COMEX board commented: "I'd still like to know what the Hunts' motive was," he says. "I know what ours was -



to regulate a market."<sup>34</sup> Yet, history, this long-lived judge, has not passed judgment that they were wrong.

Consequently, two things are clear: there are stocks overhanging the market and they are large in the hands of countries and private individuals. In turn, it is also clear, that the market is being regulated.

#### U.S. Stockpile

As a final comment, there is a certain stockpile of silver which is presently in the hands of the Government of the United States. According to ABMS., p. 146, this stock amounts to an inventory of 139,500,000 troy ounces of silver, and U.S. budget makers are reported to have their eyes on this silver lode, too, which could be sold to finance the filling of the other holes in the strategic stockpile of the United States (E&MJ, Ap. '81, 11). Until completion of such disposal operations the price of the metal must remain low. However, historically, it has been shown that prices tend to move upward subsequently. This leads us to the discussion of prices.

## SECTION V: THE FUTURE OF SILVER

### Prices

#### Historical Prices

Silver prices have been traced back in this study until the year 1897.<sup>35</sup> In retrospect, it is fair to say that these values have displayed great stability from 1897 right until after the First World War, when they started to rise above their customary 50 to 60¢/oz annual range. In 1919, the silver price hit the \$1.00/oz mark for the first time as it stood at \$1.11/oz. It returned to its original level and stayed there until 1928.

When the depression set in, the price of silver started to slide. In 1930, it hit a low of 32.64¢/oz and a high of 45¢/oz. The annual average settled at 38.15¢/oz. The all-time low was achieved two years later when an ounce of silver sold for 25.01 cents; its high for that year was 30.14 cents per ounce with an annual average of 27.89¢/oz. The annual average prices for all years are given in Table 10 and Exhibit 1.

Until 1945, silver prices stayed in the 35 - 45¢/oz range and from 1946 to 1961, the range in which silver prices moved was in the limits between 71.82 and 92.45¢/oz. After this

Table 10

Silver Price (Annual averages) for the Years 1897-1980  
in U.S. cents per ounce (current values)

1897	59.79	1918	96.77	1939	39.08	1960	91.38
1898	58.26	1919	111.12	1940	34.77	1961	92.45
1899	59.58	1920	100.90	1941	34.78	1962	108.53
1900	61.33	1921	62.65	1942	38.33	1963	127.91
1901	58.95	1922	67.53	1943	44.75	1964	129.30
1902	52.16	1923	64.87	1944	44.75	1965	129.30
1903	53.57	1924	66.78	1945	51.93	1966	129.30
1904	57.22	1925	69.07	1946	80.15	1967	154.97
1905	60.35	1926	62.11	1947	71.82	1968	214.46
1906	66.79	1927	56.37	1948	74.36	1969	179.07
1907	65.24	1928	58.18	1949	71.93	1970	177.08
1908	52.86	1929	52.99	1950	74.17	1971	154.56
1909	51.50	1930	38.15	1951	89.37	1972	168.40
1910	53.49	1931	28.89	1952	84.94	1973	255.76
1911	53.30	1932	27.89	1953	85.19	1974	470.80
1912	60.86	1933	34.77	1954	85.25	1975	441.85
1913	59.79	1934	47.97	1955	89.10	1976	435.35
1914	54.81	1935	64.27	1956	90.82	1977	462.30
1915	49.68	1936	45.08	1957	90.82	1978	540.09
1916	65.66	1937	44.88	1958	89.04	1979	1,109.42
1917	81.42	1938	43.23	1959	91.20	1980	2,150.00

Source: The Statistical History of the United States from Colonial Times to the Present.

Washington, 1962.

Neal Potter and Francis T. Christy, Jr., Trends in Natural Resource Commodities, Resources of the Future, John Hopkins, 1962; Engineering and Mining Journal.

A.B.M.S. Non-ferrous Metal Date, New York, N.Y. - 1979

A.B.M.S. Yearbook, 1951 (1950) -

Exhibit 1

Silver Prices in Current \$U.S./oz (Annual Averages)  
for the Years 1897 to 1980





period, prices started to climb. However, between 1964 and 1966, when the United States Treasury annually pressed into coinage as much silver as it at one time had lent to Oakridge, prices appeared fixed at \$1.29/oz. The futility of this official disposal of silver was recognized when, after the huge coinage operations were over, the silver price started to take off!

From \$1.54/oz in 1967, it moved to \$2.14/oz in 1968, and then back to \$1.77 in 1970. Three years later it averaged \$2.55/oz to close at \$11.09/oz and \$21.00/oz in 1979 and 1980 respectively. The highest price was reached on January 17, 1980, when it sold for \$48.70/oz; quite a rise from the 25.01¢/oz of 1932!

As indicated, these prices were not fixed but fluctuated freely. In this, they differed fundamentally from those of the other precious metal, gold, which had been fixed. The swing differences between the annual high and lows showed a certain regularity for at least a number of years. In the 1930s, their highest difference in any one year was 20 cents; this occurred in 1953. The lowest difference was 2 cents, recorded in 1938. In the 1940s, 20 cents again was the largest spread between highs and lows in a year, and that year was 1946. During the war years, 1943-1945, the difference was zero. In the 1950s, the largest difference was 9¢/oz and the lowest again zero (1954).

In the 1960s, however, this performance changed. The swings became larger, reaching an amplitude of 77¢ in 1967, although the lows were still zero, but they occurred prior to that year, viz, in 1960, and 1964-1966, the years of U.S. Treasury release of silver for coinage.

The picture for the 1970s changed dramatically as shown in the following breakdown:

1970	26	1976	75
1971	41	1977	44
1972	51	1978	99
1973	112	1979	1,553.9
1974	180	1980	3,438
1975	84		

From a low of 26, the spread reached 1,553.9 in that hectic year, 1979. The difference for 1980 merely reflected the slump which hit the silver market. Under these circumstances, it is then hard to determine offhand what the normal price actually is. The reasons for these wide and wild swings have to be seen in the uncertainty in the field of foreign exchange rates, in the oil price increases and the money creation ad absurdum. A flight of money into silver resulted and the silver prices behaved in unison with the price of gold to which it was linked - in a monetary sense - as a precious metal. Thus, silver too had left its price moorings between which it had normally fluctuated. It went up in no proportion to the underlying economic realities of consumption and supply!

### Future prices

The trend of future silver prices, expressed in constant 1979 currency are presented in Table 11 and in Exhibit 2. During the period from 1980 to 1984, the price of silver will only increase by 52¢/oz. As a matter of interest, for the years 1980 to 1982, the prediction calls for a reduction in the annual average price of silver; only then will it continue its upward movement. Even this rise will be gentle and not as eruptive as what occurred during the period 1979/1980. Yet, this is not to imply that the price will not vary. These predicted prices represent a trend line around which silver prices will fluctuate.

According to the econometric model, the silver price will rise to about \$19/oz in the year 1990 and only in 1991 will it be the same as the actual annual average of the year 1980.<sup>36</sup> In 1995, it is expected to average \$30/oz and by the year 2000, the prediction goes for a value of \$49.75/oz. Eventually, so the prediction tells us, silver would sell for \$73.62/oz in the year 2004.

The authors feel very confident about the predictions of the silver price over the 1980s well up to the year 1990. After that, the conviction starts to wane slightly, although the model may be much more powerful in its predictive capacity than the authors are ready to accept. Let us not forget that prices have moved dramatically over the period under study. Who would

Table 11

Silver Prices in Constant 1979 U.S. cents per ounce;  
World Supply and 'World' Consumption in metric tons

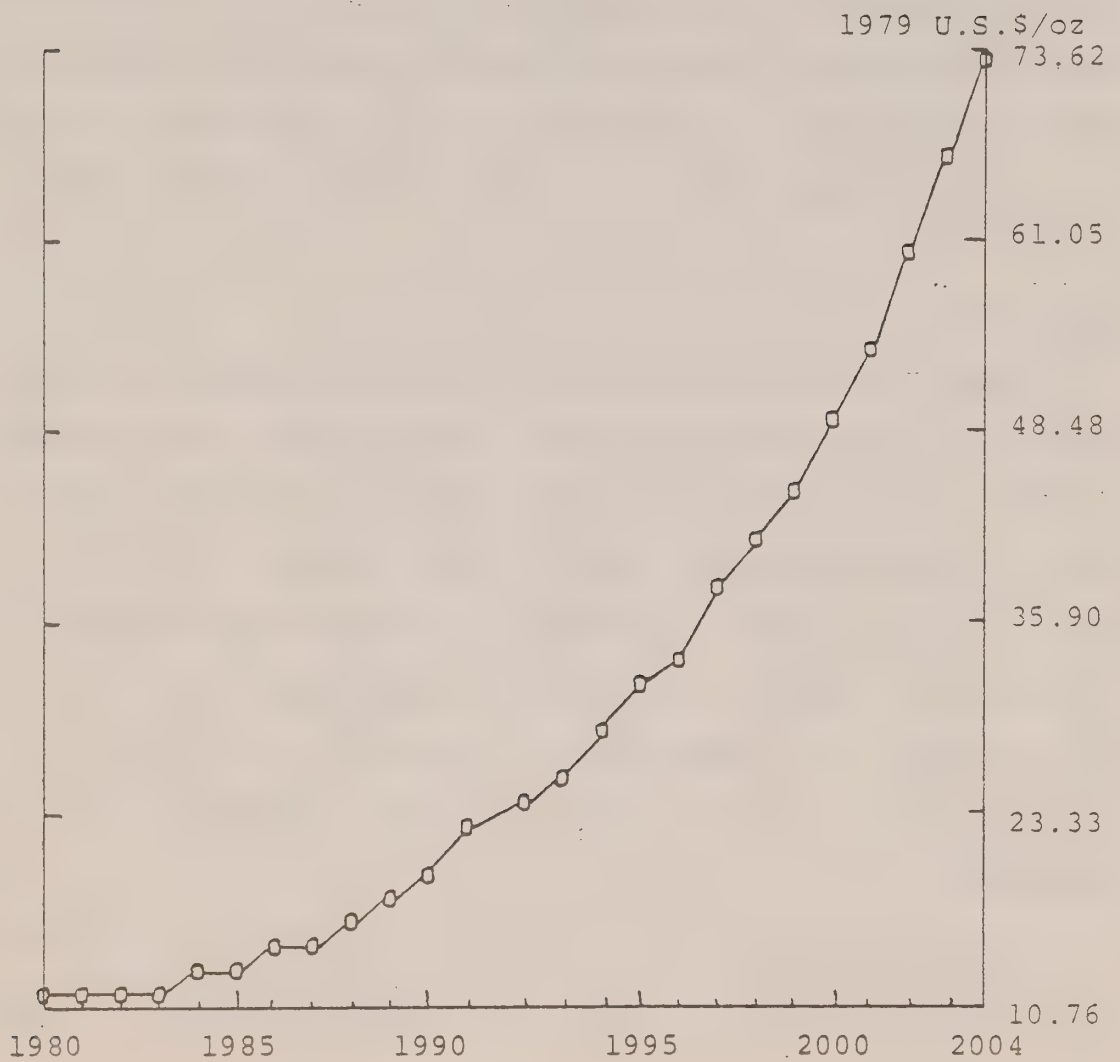
Year	ct/oz	Supply	Partial World*) Consumption
1980	1,075.79	11,554.7	12,754.0
1981	1,047.27	12,301.4	13,030.3
1982	1,044.23	12,854.5	13,265.9
1983	1,071.31	13,308.2	13,480.2
1984	1,127.15	13,732.9	13,686.3
1985	1,208.64	14,172.8	13,891.9
1986	1,312.52	14,651.0	14,101.0
1987	1,436.06	15,176.8	14,314.7
1988	1,577.26	15,751.3	14,532.9
1989	1,735.04	16,371.7	14,754.9
1990	1,909.27	17,034.4	14,979.9
1991	2,100.63	17,736.1	15,206.9
1992	2,310.54	18,474.3	15,435.5
1993	2,540.98	19,248.1	15,665.4
1994	2,794.40	20,057.3	15,896.3
1995	3,073.58	20,902.8	16,128.2
1996	3,381.64	21,786.1	16,361.2
1997	3,721.95	22,708.9	16,595.2
1998	4,098.22	23,673.3	16,830.5
1999	4,514.50	24,681.4	17,067.0
2000	4,975.22	25,735.6	17,304.8
2001	5,484.92	26,837.9	17,544.0
2002	6,048.72	27,990.3	17,784.6
2003	6,672.29	29,195.0	18,026.6
2004	7,362.04	30,454.2	18,270.0

\*) excluding coinage.



Exhibit 2

The Price of Silver in Constant 1979 \$U.S./oz  
for the Years 1980-2004



have predicted in 1951, for instance, when the constant price was \$2.58 - or \$0.89 in current dollars - that it would have gone up to \$18.91 (constant \$) - 21.00 current \$ - in the year 1980? This was a sevenfold increase in constant and a 23.6 fold increase in current prices over this period. Constant prices will increase sevenfold, too, over the next 25 years; that is what the econometric model predicts. Even if that prediction appears unreasonable, on second thought, perhaps, it may have more merit than one is inclined to give it credit for. Naturally, some modifications will have to be made further below.

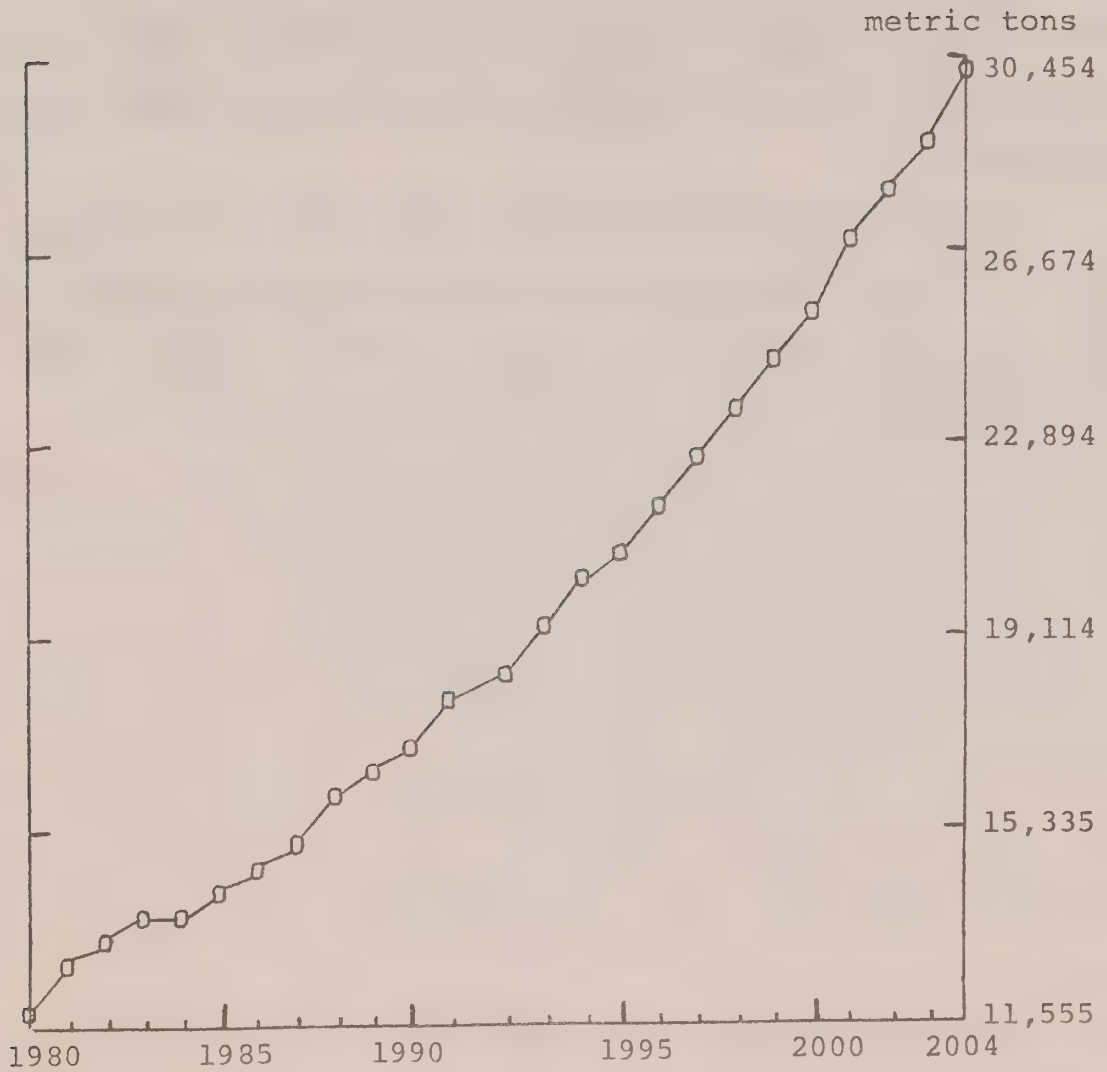
#### Supply (Exhibit 3)

The forecast is a very slow increase in output at the beginning of the forecast period. From 11,551.7 metric tons in 1980, it will rise to 17,034.4 metric tons in 1990, which amounts to an increase of 5,482.7 metric tons or by 548.27 metric tons per annum. According to the previous discussion of alternative supplies, the wheels of investment may have been set into motion to substantiate at least this prediction. Therefore, this forecast cannot be easily discarded as unrealistic.

By the year 2000, the forecast is that silver mines of the world will deliver 25,735.6 metric tons annually, an increase

Exhibit 3

Silver Mine Supply of the World for the Years 1980 to 2004  
in metric tons



of 8,701.2 metric tons annually over that level predicted for the year 1990. The average annual addition to silver output would be 870 metric tons. This is quite possible in light of the expected rise in silver prices, which, of course, are a distinct reflection of the rising costs of expanded silver operations. The year 2004, so the econometric model states, will see a world silver mine output of 30,454.2 metric tons, or a rise by a factor of 2.9 over the output of 10,519 metric tons achieved in 1979.

It has to be understood that these supplies of newly mined silver are integrally connected to the high prices which make this output possible. Should, for certain reasons, the predicted prices fail to materialize, then of course, the supplies will also deviate from the predicted values and vice versa.<sup>37</sup> It has to be recognized that next year's output is highly dependent on the previous year's production of silver. Once output has declined in one year due to huge price decreases, the subsequent output is aligned to the volume of the previously mined silver. Only substantial increases in prices can eventually raise that output and with it the following year's production.<sup>38</sup> That is why over the next years, world output will rise but slowly.

The production of newly mined silver would amount to the following cumulative totals:



1985	77,924.5 metric tons
1990	156,909.7 metric tons
1995	253,328.3 metric tons
2000	371,913.6 metric tons
2004	487,391.0 metric tons

Were the world to maintain its 1979 output level of silver of 10,519 metric tons, after twenty-five years, 262,975 metric tons would have been taken from the ground. With the projected annual increases in world output, this total of about 250,000 metric tons will be reached much earlier, a point which will be discussed at the end.

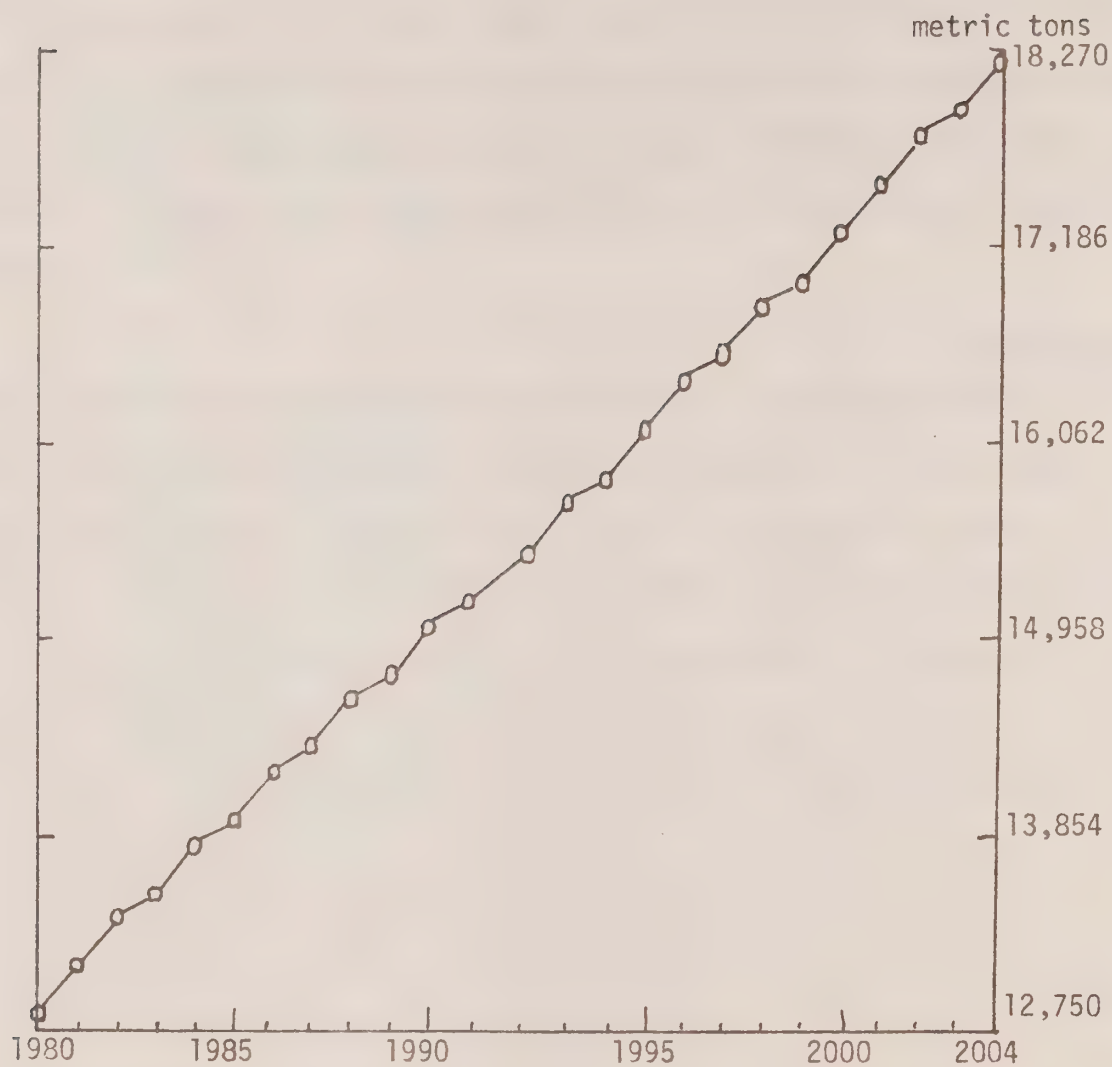
#### Consumption

The consumption forecast is presented in Table 11 - third and last column; it has also been reproduced in diagramatic form in Exhibit 4. However, it has to be pointed out that this consumption series excludes the use of silver for coinage. As has been discussed in the consumption section, coinage of silver in the United States came mainly from silver inventories. Therefore, no direct functional relationship exists between mining supply of silver and its consumption; at best the relationship is indirect. Were coinage to be included an absolute decline in future world consumption of silver would be indicated. Such a performance, of course, is not acceptable at this point in time.

In short, annual consumption of silver excluding coinage in the partial world is expected to rise by 5,516 metric tons

Exhibit 4

Partial World Consumption of Silver for the Years 1980 to 2004<sup>\*)</sup>



<sup>\*)</sup> excluding coinage.

from 12,754 to 18,270 metric tons over the entire forecast period. This amounts to an increase in annual silver usage over this time of 43.2 percent which would appear fairly optimistic. Therefore, some comments are in order at this juncture as regards the nature of the consumption forecast.

At first, a comparison between this consumption and the supply of mined silver displays larger consumption values for the first four years until 1983. In the following years, consumption falls below the mined supply. In retrospect, a similar comparison of these two series showed that historically until 1958, consumption of silver by arts and industry (excluding coinage) had been almost in balance with mined silver. The following breakdown is to illustrate this fact.

<u>Metric Tons</u>		
<u>Year</u>	<u>Mined Silver</u>	<u>Silver Consumption</u>
1951	5,400	5,131.5
1953	6,100	5,234.1
1955	6,100	5,990.9
1957	6,500	6,624.3
1958	6,600	5,828.1

Since 1959, however, the historical performance picture saw silver consumption continuously exceeding the annual quantities coming from the silver mines. This is demonstrated by the following breakdown for selected years:

<u>In Metric Tons</u>		
<u>Year</u>	<u>Mined Silver</u>	<u>Silver Consumption</u>
1959	6,200	6,587.0
1960	6,300	6,985.1
1965	6,800	10,468.3
1970	9,620	10,539.8
1975	9,330	11,718.5
1979	10,519	12,751.0

This difference may be explained through consumption of secondary silver which may have played an increasingly important role. It is included in the consumption figures. Obviously, the rising use of silver, especially in photography, made the recovery of spent silver increasingly feasible. Naturally, this behaviour will continue with the expansion of the volume of silver consumption in general.

Nonetheless, the prediction from the year 1985 on also tells of the future supplies of mined silver to exceed the annual consumption figures. This is the second point of observation which holds equally true for almost all the other minerals of this study. As regards silver, this type of prediction contradicts the basic historical argument just presented. Yet, it should be kept in mind that the consumption equation of the econometric analysis served mainly a mathematical-analytical-technical purpose, viz. to close the system of equations. This implies that mineral consumption here as much as in the following mineral reports is chiefly included for reasons of estimation. It is not to be confused with the demand for mined silver as has been discussed above.<sup>40</sup>

One final question remains: How will the holders of silver stocks - the wealth holders, whoever they may be - act in this type of a future?



For years on end, the real wealth holder saw a low price fluctuating within certain ranges and it was within these limits that the speculator and trader could operate. When finally the price of silver jumped, some wealth holders may have used this opportunity to divest themselves of silver; this may have been done in the hope to buy silver back later or to buy gold - as it is customary in India - or to buy other assets. However, the time will come - and one should think here of the middle of the 1980s - that the continuously rising trend will become apparent. Since it will be a rising price in constant 1979 dollars as predicted here, the silver market price in current dollars will rise faster than the rate of inflation. The opportunity cost of foregoing interest rate earning which is the fate, normally, of real wealth holders of this variety, will be modified greatly because there is now a built-in upward trend that should persist with some minor modification to be brought out later.

The rise in real prices means that the silver holder earns something above the rate of inflation. He earns a return, which, in the field of capital theory is called interest. However, the earnings do come from a resource that has been dug out of the ground - in previous years! It will cost much more in the future than what the silver stock did cost earlier.

This difference is a return to the silver wealth holder. The producer has to spend the money to mine the additional ore, a cost which the wealth holder does not incur. He earns an economic rent! Why should the wealth holder dispose of his wealth, if that rent increases over time faster than the rate of inflation? Under the conditions of certainty of expectations, the silver holder would stay put. However, when the final tally is in, aspects of uncertainty cannot be removed from reality. Some wealthholder may sell more at times than other participants in the market may be willing to buy.

## SUMMARY AND CONCLUSION

Silver provides services for industry and it is connected to the monetary side of the economy where it functions as a store of value and wealth. To judge by the consumption behaviour of the United States, larger and larger amounts of silver are being absorbed by photography, catalysts and electro-related industries; jewelry displays only a slowly rising demand for the metal. Other applications of silver, such as in silverware, brazing alloys and solder, dental and medical supplies, as well as in mirrors, reflect a generally unfavourable demand picture.

The issuance of silver coins for currency purposes has been almost completely discontinued, and if silver coins find a use, then, mainly through commemorative coins and medallions only.

Although the United States is still the largest consumer of silver in the world, the demand for silver has been rising much faster in the other industrial countries. Unfortunately, the picture is incomplete as industrial consumption of only a few, though the most important, countries has been assessed and estimated; it is called 'world' consumption! No information is available on the consumption of silver in the centrally-

planned economies!

Among the industrialized countries - outside the United States - for which consumption figures are available, the volume of silver demanded is the greatest in Japan, followed by France and the United Kingdom. Italy and India are likewise strong consumers of silver.

Silver mine production in the world - excluding the U.S.S.R. for the years 1950 to 1967 - almost doubled between 1950 and 1979; when estimates for the U.S.S.R. are included, the increase was about 68 percent. There are about fifty silver-producing countries in the world.

Three quarters of world silver mining output comes from seven countries, while 15 percent is the production of another nine medium-sized countries; the remainder of 10 percent is produced by the small producers.

In 1979, the largest producers were Mexico, U.S.S.R., Canada, U.S.A., Peru, Australia and Poland, which emerged quite suddenly as a significant and large supplier of silver in the 1970s. Medium-sized producers are mainly Japan, Chile, Bolivia, Sweden and Yugoslavia.

Canada exports more silver than its mines produce. These exports take the forms of ores, concentrates and refined metal: The balance of payments is very positively affected, especially



as the price of silver has been on the increase!

World silver reserves are 250,000 and 704,000 metric tons over the short and long runs respectively. The distribution of reserves reflects the output distribution of the main producers. The largest reserve holders are the U.S.A. and the U.S.S.R., followed by Mexico, Canada and Peru. Australia and Poland are also endowed with substantial reserves.

In most countries, silver is a by-product of base metals such that the conditions and activities in these mineral sectors of the various countries affect and determine the silver performance significantly. The exceptions in this context are Mexico and Bolivia which have an overwhelming proportion of native silver mines; the United States has both native silver and polymetallic silver reserves.

The investment picture for the main producers differ among countries. In the U.S.A., the decline of zinc and lead mining has placed a new onus on the exploitation of native silver mines, a condition which is favourably influenced by the rising price of the metal.

In the U.S.S.R., the expansion of the base-metal industry assures continuously increasing supplies of the metal. This holds true also for Australia. It was also noticed that a substantial expansion program is taking place in Mexico, which

will raise its silver production significantly over the years to come. Some investment is taking place in Peru, while the picture for Bolivia is essentially unclear, if not politically uncertain.

Yugoslavia - and this would hold true for Poland as well - will increase silver production as their base-metal operations gather steam. Sweden, which recorded an exceptional production increase over the period under study, is another country to be reckoned with, although no sufficient information was available to support this argument.

It is also recognized that existing stocks may influence the climate in the silver market. Although no exact details are available on a global basis, some countries such as India, China and Pakistan are actual (India and Pakistan) or potential (China) suppliers from huge stocks. China, incidentally, will also supply silver as a by-product from its base-metal operations which promise a great expansion - leap forward - in the years to come!

In addition, substantial silver holdings are in private hands with examples to be found in and outside the United States.

The price of silver has been stable for almost a century until 1961. After that year, silver prices increased with a panic driving the price unreasonably high in 1980. During that year, it averaged \$21.00, but has declined ever since. This

price explosion was the result of many factors, not in the least that of a general lack of credibility in deposit and paper currency, which was to haunt the western countries.

In contrast to the price of gold which had been fixed for centuries, the price of silver fluctuated freely. Over time, and especially during the 1970s, the price swings became more and more pronounced. On January 17, 1980, a price of \$48.70/oz was recorded.

Future prices in constant 1979 U.S. dollars will rise and by 1990, the same price of \$21/oz will be seen as in 1980 - to which an inflationary adjustment has to be added. From then on, the silver price is expected to increase systematically.

According to the same econometric model, the supply of mined silver will also climb steadily from 11,554.7 metric tons in 1980 to 25,735.6 metric tons in the year 2000 and to 30,454 by 2004.

Cumulative production will be 253,328.3 in 1995, 372,913.6 in 2000, and 486,391 in 2004.

World demand for silver is determined by the size of the GDP of the world while high present prices affect the demand negatively. This also holds true for technological change which has silver-saving effect; also relative certainty in the area of rising prices may prevent silver holders from disposing of silver stocks.

Finally, one important point has to be recalled. It must be remembered that there are substitutes available, and according to the economic law of substitution, they will come into operation when the silver price is sufficiently high. Photography has been heralded as one of these important areas of substitution.

The conclusions can now be drawn:

Mine production of silver, if maintained at the 1979 level, would exhaust short-run reserves by the year 2004; according to this forecast, depletion would occur in 1995. Should annual silver production be less than predicted, the year of depletion will move closer towards the end of this century. To maintain silver output at expected levels, long-run resources must become minable ores: This is only possible if the price goes up.

Therefore, the second conclusion is that the price of silver m u s t r i s e regardless of the surrounding monetary conditions and the credit climate.

#### Modification

Furthermore, the effect of substitutes will enter into the picture. The most imminent event will be the appearance of substitutes replacing silver in photography, its single most important application. It may be only a question of time until the whole field of photography becomes desilverized. The



chemistry is known; the processes are patented. However, Kodak, for the time being, is holding onto silver photography in the amateur market;<sup>41</sup> and if Kodak does not introduce non-silver photography, the Japanese will, especially when the patents expire around 1995; the year the silver prices are predicted to rise sharply.

When this photographic demand for silver will enter the point where it is being phased out - and this will occur definitely after 1995, if not before - a downward shift in demand will take place, to use the economist's jargon. This reduction, however, will not come abruptly but gradually. Perhaps the effect of the reduction of lead additives on the demand and supply of lead could be used for an example. This shift will modify the expected price increases, extend the horizon of exhaustible short-run resources and reduce the value of mineral properties through the discounting process. In turn, it will raise the probability that more wealth holders of silver will be inclined to dispose of silver stocks than otherwise would have been the case. The increased uncertainty will leave more room for price movements to speculators and traders than would have been the case would desilverization of silver not have taken place. This scenario will, most likely, unfold between 1990 and 1995. Until then, the forecast stands.

Finally, it would appear that more investment in the silver mining industry should be forthcoming at the end of the 1980s and the early 1990s. The extent to which the desilverization of photography will postpone investment cannot be ascertained. Such postponements, in turn, would eliminate some of the excess of future supply emanating from the expected phasing out of photography as the major silver use.

Finally, there is no doubt that Canada and its mining industry will continue to benefit from the exports of silver, especially as concerns the balance of trade - and payments - which will continue to be positively affected by rising foreign revenues, particularly under conditions of rising silver prices. It is also clear that this forecast as much as all the others of this study are based on the crucial assumption of the expected UN growth rates for the world GDP (without services). Given the economic policies of the Reagan Administration in the U.S.A., our predictions would take the form of optimal values as long as these policies are carried through. It also means that caution and concern expressed about a possible drastic decline of the price of gold in the future under these highly restrictive monetary policies as stated in the gold report (p. 76-77) holds as much for silver as for all the other metals. In turn, such a policy would effectively reduce actual world growth rates below what had been built into the econometric analysis and, correspondingly, would lower supplies and demand of the minerals, at least, over the period that these policies are in effect.

NOTES

- 1 Silver is also a metal of good resonance.
- 2 The scientific symbol for silver is Ag; it has an atomic weight of 107.88 and a specific gravity of 10.5; the melting point is at 1,790°F. Probability of occurrence is 0.2 ppm.
- 3 Oak Ridge, The City That Changed the World, The Delmar Company, Tennessee, 1976, p. 17.
- 4 In those years, the United States Treasury released considerable quantities of silver which went mainly into coinage.

	millions of tr. oz.	metric tons
1964	353.1	10,982.9
1965	400.8	12,466.6
1966	196.4	6,108.9
1967	233.1	7,250.4
1968	193.1	6,199.4
1969	76.7	2,385.7
1970	30.5	948.7
1971	2.5	77.8

Source: Thomas G. Clarke, "Silver", U.S.B.M., Mineral Facts and Problems, 1975, p. 1009, Table 4.

- 5 Ibid.
- 6 As will be shown later, the price of silver in current U.S. dollars was \$1.2791 in 1963 and \$1.2900 from then until 1966, after which it rose strongly to \$1.5497 (1967), and \$2.1446 (1968). Cf. Table 10, *infra*, p.59.
- 7 See Ch. I, *supra*, Figure 2, p. 39.
- 8 The econometric analysis has used dummy variables to isolate this obvious discrepancy.
- 9 In 1978, the following figure described the production of refined silver for consumption:  
1978 silver source in million of ounces  

Primary production	from coins	old scrap	total without runaround
54.38	1.15	57.82	113.35

10 The role of India (and Pakistan) will be explained in Section IV.

11 Estimated U.S.S.R. silver production (in million of troy ounces)

1950	24.0	1955	25.0
1951	24.0	1956	25.0
1952	24.0	1957	25.0
1953	25.0	1958	25.0
1954	25.0	1959	25.0

Source: Commodity Yearbook 1960, p. 229.

12 Poland produced silver in the following years (in metric tons).

1931	17.4	1936	1.9
1932	2.1	1937	2.0
1933	1.3	1938	1.9
1934	0.7	1939	1.9
1935	1.0		

Source: United Nations, Annual Yearbook, New York, N.Y.

13 M.G. Fleming, loc. cit.

14 Normal reservations expressed about the correctness of these estimates need not be repeated.

15 703,888 metric tons or 22,630,000,000 million ounces.

16 This is not specified. It is the difference between stated total reserves and reserve values attributed to various countries.

17 See Thomas G. Clarke, "Silver", U.S.B.M., loc. cit., p. 1005, Table 3.

18 Cf. ABMS, 1979, pp. 105-106.

19 See also Donald A. Pazour, "Lampazos silver mine: small but profitable," World Mining, October 1980, pp. 50-53. Grades are: Gold: 0.007 ounce/t; silver: 12.3 ounces/t; lead: 0.54%; zinc: 0.45%; copper: 0.10%.

20 "Mexico levies a tax on gold and silver," American Metal Market, vol.88, No.19, January 29, 1980, p.1.

- 21 The 1979 value is based on ABMS, 1979, op. cit., p. 100, although M.A.R. 1980, op. cit., p. 419, sets output at 814.775 metric tons.
- 22 0.4% copper, 7% lead, 12.5% zinc, 171 grams of silver per ton and 3.4 grams of gold per ton.
- 23 IMMR, 1979, op. cit., "Peru", p. 7.
- 24 Engineering and Mining Journal, March 1980, p. 89.
- 25 M.A.R. 1980, p. 371.
- 26 Compania Minera del Madrigal has a mine 100 km. north of Arequipa in southern Peru, in a mineral area known for centuries. It started operations in 1972. Ore grade: 2.2 ounces of silver per ton plus 2.2% of lead, 4.8% of zinc and 1% of copper. See Robert J.M. Wyllie, "Minera Madrigal goes deeper for more tonnage," World Mining, Oct. 1980, pp. 60-63.
- 27 IMMR, 1980, p. 147.
- 28 Laisvall has a known ore reserve of 32 million metric tons and a potential of 60 million tons of 4.26 percent lead, 0.74% zinc and 10 grams of silver per metric ton.
- 29 Cf. M.A.R. 1980, pp. 550-552; World Mining Annual, July 1980, pp. 112-114, and IMMR 1980, pp. 143-149.
- 30 In 1979, the Philippines produced 56.7 metric tons of silver, or 1,824,000 ounces. This was a considerable increase after the output had remained stable around and below 50 metric tons since 1975. Strong silver prices will contribute to an even better performance in the future, as can be seen from the increase in 1979 over 1978 amounting to 9%. This is smaller than stated at other sources: cf. IMMR, 1980, p. 540 maintains that silver output rose by 20%. The Philippines belong to the small pre silver producing countries.
- 31 IMMR, 1979, "India".
- 32 M.A.R. 1980, loc. cit., p. 448.
- 33 Roy Rowan, "A Hunt Crony Tells All," Fortune, June 30, 1980, p. 60.
- 34 -----, "Who guards Whom at the Commodity Exchange," Fortune, July 25, 1980, p. 40.



- 35 For further information, see Schmitz, op. cit., under "Silver prices," pp. 289-292, where this stability of British silver prices can be pinpointed back to 1701.
- 36 The reader would have to add inflationary effects to these prices!
- 37 See the positive coefficient for supply as to  $P_t$  of 0.126 on p. 23, Ch. I.
- 38 Ibid.
- 39 Cf. Table 4, supra.p.24.
- 40 Ibid., n. 37.
- 41 Joseph Rosta, "Prices and Demand tumbled after Prices Peaked Near \$50 In early 1980," Engineering and Mining Journal, March 1980, p. 161.

## APPENDIX



Table A1

Consumption of Silver by Type of Usage in the United States  
for the Years 1978 and 1979  
(millions of troy ounces) and percents

	Quantity		% of silver use	
	1978	1979	1978	1979
Brazing and soldering	12.1	(-) 11.6	8	7
Electrical and electronic	36.5	39.6	24	24
Photographic	59.3	(-) 62.7	39	38
Catalysts	7.6	8.3	5	5
Coins and medallions	3.0	3.3	2	2
Jewelry	4.6	6.6	3	4
Silverware	24.3	(-) 28.0	16	17
Miscellaneous	<u>4.6</u>	<u>4.9</u>	<u>3</u>	<u>3</u>
	152.0	165.0	100	100

Source: Richard L. Davies, "Silver Supply and Demand in  
Balance in a period of price volatility."  
Engineering and Mining Journal, March 1980, p. 199

Table A2  
U.S. Consumption of Silver

1964	million troy oz.	%
Silverware	46.0	28.34
Jewelry and Arts	5.5	3.39
Photography	45.1	27.79
Refrigeration	9.1	5.61
Coinage	(203.0)	
Appliances and equipment	9.7	5.98
Batteries	10.9	6.71
Electrical equipment	18.4	11.34
Electronic components	8.8	5.42
Coins, medallions, etc.	---	---
Others	<u>8.8</u>	<u>5.42</u>
	162.3	100.00
	(365.3)	

Source: Clarke, loc. cit., p. 1009, Table 4.







